

Exhibit 2

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used to separate widely the divided sternal edges, tilting the spreader to elevate and rotate the left-sided sternal fragment. Alternatively, the Favaloro retractor is used (UAB). The operating table is rotated to the left to expose better the undersurface of the left sternal fragment and the left IMA. The pedicle to be dissected consists of the IMA, the internal mammary vein, fat, and some muscle and pleura. A diathermy cut is made down the sternal side of the artery and vein, about 5 mm from the IMA along the full length from the sixth intercostal space to the first rib. The dissection is begun at the sixth space, where there are no branches. The pedicle is freed from the underlying sixth costal cartilage. Through blunt dissection with a dissector and scissors, the intercostal arteries are identified in turn as they arise from the lateral aspect of the pedicle. They are occluded with clips or ties on the artery end and by diathermy on the chest wall end, and divided. The IMA must not be grasped with instruments, but only gently retracted.

The pedicle is freed in this fashion up to the first rib and then wrapped in a papaverine-soaked gauze swab (20 mg of papaverine diluted in 20 ml of saline solution). The distal end of the pedicle is not divided until the patient is heparinized and everything is in readiness for CPB. At this time, the pedicle is tied distally at the sixth intercostal space, transected, and free bleeding is allowed from the proximal end. If the IMA is of good quality and the bleeding is brisk, the graft is considered to be satisfactory and a very light bulldog clamp is placed on the distal end of the pedicle. The pedicle is sprayed with dilute papaverine and left lying loosely anterior to the lung.

After completing the distal vein anastomoses and opening the LAD artery, the IMA pedicle is brought into the surgical field. The other elements of the pedicle are dissected away from a 1-cm segment of the internal mammary artery just proximal to the place where it will be transected for a proper fit to the LAD artery. The IMA is generally dilated with a 1.0-mm and then a 1.5-mm dilator and is then sharply divided obliquely. The anastomosis to the LAD artery is made with interrupted 7-0 silk or polypropylene double-armed sutures, passing the stitches from inside-out in both the IMA and the LAD artery. After the anastomosis is completed, the important step of tacking the pedicle to the cardiac surface with a few interrupted sutures is performed, to prevent any tension on the suture line. Finally the pericardium is cut down transversely on the left side to allow the pedicle to pass smoothly to the LAD artery.

The Distal Anastomoses

The epicardium is incised over the area of the coronary artery that has been selected for the anastomoses, using a no. 15 Bard-Parker blade on the scalpel. Some use special scalpels with a completely rounded end. The anterior surface of the artery is cleared by gentle transverse brushing with the scalpel. Careful inspection of the artery will then reveal, even with cardioplegia, a thin central line, which is red or translucent and indicates the lumen. The anterior wall of the artery is opened longitudinally over this line, caressed gently with the scalpel so as not to damage the posterior wall. Occasionally, when the anterior wall of the artery cannot be placed under proper tension, it may be opened by stabbing

with a special small sharp-pointed scalpel. The blade must enter the artery obliquely, so that it does not penetrate the back wall. The incision is enlarged with fine, angled scissors to a length of 4–6 mm. The epicardial incision must extend beyond each angle of the arteriotomy, to facilitate the anastomosis. Generally the artery is sized by passing measured probes into it, and proximal and distal patency is assessed.

The vein is opened longitudinally for all sequential anastomoses by a similar technique, at precisely the place that has been determined by vein distention to be the correct location of the anastomosis. The incision is made about 10%–20% longer than that in the artery, and the suture bites in the vein are placed slightly farther apart than those in the artery, to make the desirable “cobra head” of the vein over the artery. When the end of the vein is being prepared for the most distal anastomosis, it is cut in a beveled fashion (Fig. 7-5) so that the circumference of the opening is somewhat larger than that of the opening in the artery.

The technique of anastomosis utilizes one double-armed 6-0 polypropylene suture placed as a continuous stitch. Stitches in the artery classically go from intima to adventitia (inside to outside), and the stitch pierces the intima near the vessel edge but often emerges through periarterial fat or muscle 2–3 mm away from the edge. Stitches in the vein go from outside to inside. The stitches through vein-artery are made separately unless it is very convenient to place them with one “bite.” Even then, the vein and artery wall are held apart as each “bite” is made, so that the needle point is visualized after it has pierced one vessel and before it pierces the other, to be certain that the stitch is accurate and no extraneous tissue has been caught.

Although the actual sequence of the stitching varies from one location on the heart to another, and occasionally varies in the same location because of special conditions of exposure or arterial pathology, certain general principles are followed. When the vein and artery are to approach and depart from the end-to-side (Fig. 7-6) or side-to-side (Fig. 7-7) anastomosis *parallel one to the other*, the suturing is generally begun 2–3 mm away from the arterial (and venous) angles so that the knot is kept away from the angle. When the vein is to *cross* the artery transversely, rather than running parallel to it, or approaches it at an angle for an end-to-side anastomosis, the stitch is begun by passing the suture first *through* an angle of the *vein*, so that the only stitch requiring a judgment of distances is that next passed through the arterial wall (Fig. 7-8). This arterial stitch is placed precisely at the point where the vein angle should rest to provide the proper predeter-

end used for anastomosis

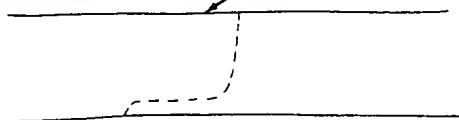


Figure 7-5 Transection of the vein for end-to-side anastomosis to the coronary artery. Normally the circumference of the vein opening is 10%–20% larger than that of the opening in the artery, providing a large hood of vein over the distal anastomosis. If the vein is a little smaller than usual, it may be cut as for a proximal anastomosis (Fig. 7-10b) to provide a large enough hood.

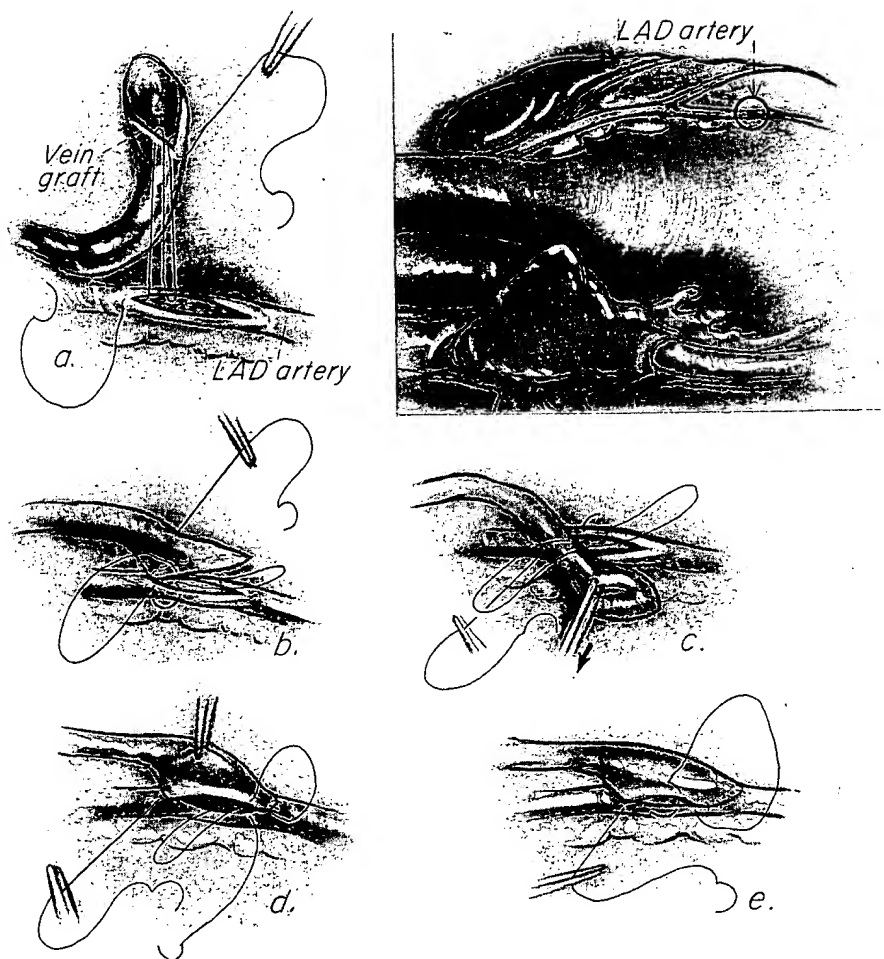


Figure 7-6 The distal anastomoses between the vein graft and the left anterior descending artery. In this and subsequent figures, the orientation is indicated by the upper right-hand drawing. (a) The vein graft is anastomosed slightly obliquely to the artery. The drawing shows the first stitch starting through the angle of the vein graft. (b) The suture line continues beyond the proximal angle of the arteriotomy. (c) The other arm of the suture has been placed from outside in through the vein and then inside out through the artery. (d, e) The suture is continued and tied to the other suture arm. This general method applies to all end-to-side anastomoses. Note that the knot is away from the angles of the arteriotomy.

mined angle of approach. In a side-to-side anastomosis, the other vein angle must rest at the corresponding point on the opposite wall of the artery so that the vein goes straight across the artery. In other words, the angles of approach and departure must be the same. The same principles apply when the vein crosses the artery diagonally. In both the parallel and crossing vein artery configurations, the sequence of subsequent suturing varies depending on location and exposure problems but is designed to provide good exposure of each stitch that is placed.

Generally the suturing is done from the outside in a more or less conventional manner. That is, the stitch passes first from outside in on the vein and then from inside out on the artery. Occasionally, exposure and suturing are easier if the stitching is done from the inside of the vessels. For this, the

vein lies alongside or transverse to the artery with the incision turned up. The suturing goes from inside out on the artery and outside in on the vein (Fig. 7-9). After doing one side, or going around one angle, in this way, the surgeon continues suturing in the more classic manner from the outside.

After suturing is completed, the vein may be distended by injecting cardioplegic solution through the proximal vein cannula as the 6-0 polypropylene suture is snugged up until there is no leakage and tied (UAB).

The Proximal Anastomoses

After completion of the distal anastomoses, release of the aortic cross-clamp, and beginning of the rewarming of the

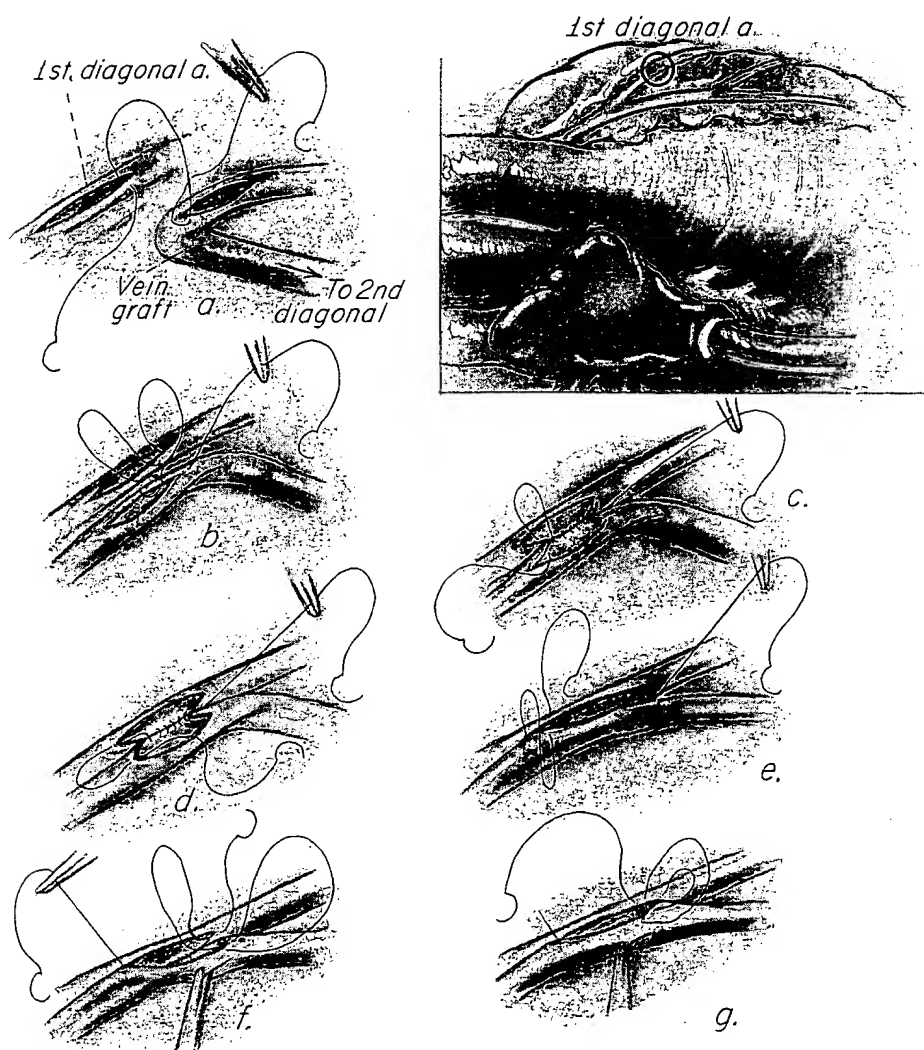


Figure 7-7 Parallel sequential side-to-side anastomosis of the vein graft to the first diagonal artery. (a) The anastomosis is begun just off the angle of the vein graft. (b, c) The anastomosis is continued from within the lumina and (d, e) carried around the proximal angle of the arteriotomy, with separate bites taken into the vein and artery. (f) The other arm of the suture is passed from outside in through the vein and (g) then used to go around the distal angle of the arteriotomy and continued to complete the suture line.

patient with the perfusate, the proximal anastomoses are made. The vein segments are appropriately routed to the area of anastomosis on the ascending aorta (see Fig. 7-4). Each vein segment is distended as described earlier, to determine precisely its proper course and length and the proper point for the proximal anastomosis marked with a light bulldog clamp.

For exteriorizing the right lateral aspect of the ascending aorta, a side-biting clamp² with a long flat blade is positioned (Fig. 7-10a). A longitudinal slit about 3 mm in length is made

at the site of each proximal anastomosis. A special punch³ with the 4.9-mm diameter blade is slipped completely and freely into the aorta through each slit and closed so as to punch out a circular piece of aorta at each site (Fig. 7-10a). The proximal end of the vein graft is cut slightly obliquely, and an incision is made on the down side so as to form a hood (Fig. 7-10b). As in all anastomoses in which the "cobra head" effect is desired, the circumference of this hooded end of the vein graft is made about 10%–20% longer than that of the circular opening in the aorta, and the stitches are placed

²Ochsner aortic clamp no. 37-1026 by Codman, Randolph, Mass. 02368.

³Goosen aortic punch no. DP-05 by Deknata, Queens Village, N.Y. 11429.